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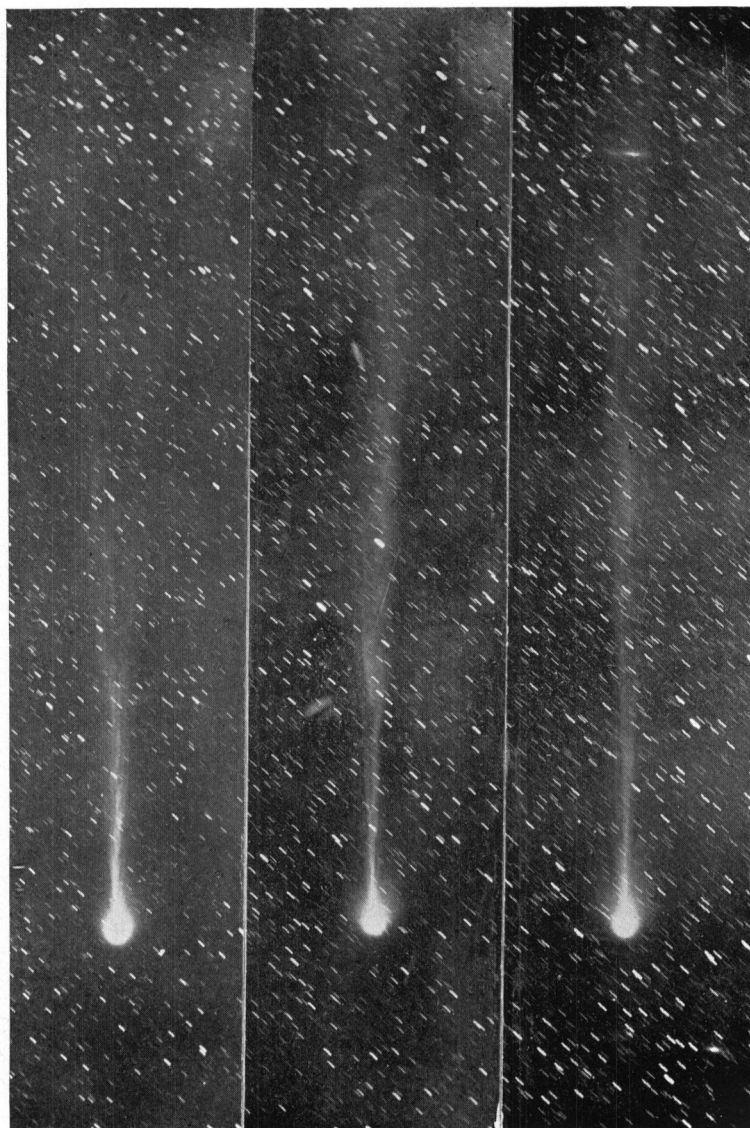
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May 8, 1899.
14^h 20^m to 15^h 30^m.

May 9, 1899.
14^h 8^m to 15^h 30^m.

May 10, 1899.
14^h 4^m to 15^h 32^m.

COMET α 1899 (SWIFT).
(Photographed by E. F. CODDINGTON.)

unlike, however, than the men themselves. "COPERNICUS was of humble origin, and certainly not wealthy; TYCHO BRAHE was of noble birth, and inherited great riches. COPERNICUS loved solitude and rest; TYCHO BRAHE restlessly moved from place to place all over Europe. COPERNICUS was calm and peaceful in disposition; TYCHO BRAHE was a man of violent temper. COPERNICUS was always tender to the prejudices of others; TYCHO BRAHE delighted in attacking false beliefs. They resembled each other in one point alone — the patient carefulness of their researches, and the strenuous earnestness of their lives."

(To be continued.)

PHOTOGRAPHIC OBSERVATIONS OF COMET *a* 1899 (SWIFT).

BY E. F. CODDINGTON AND H. K. PALMER.

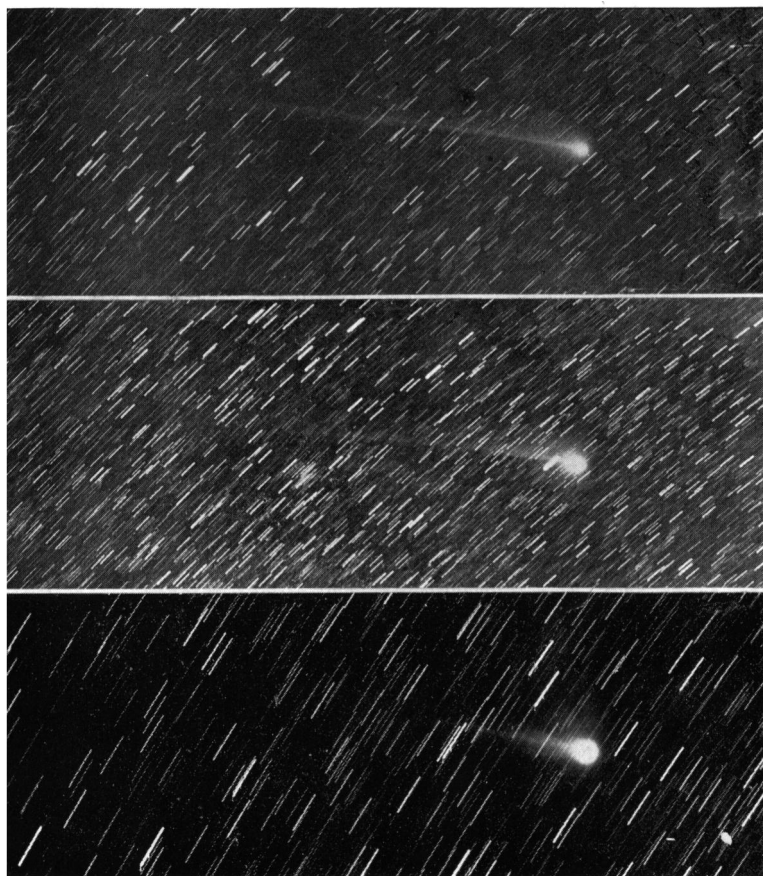
At the time of its discovery this comet was too near the Sun to be photographed. But after it had passed perihelion it became a morning object, and its apparent distance from the Sun rapidly increased. It was then photographed with two instruments at the Lick Observatory, on every suitable night from May 6 to June 13, 1899, inclusive. In all, thirty negatives were obtained. Of these, nine were taken by Mr. CODDINGTON with the Crocker photographic telescope, and twenty-one by Mr. PALMER with a 6-inch Willard lens strapped to the 5-inch Floyd telescope. The Crocker telescope is provided with a 6-inch Willard lens having an equivalent focal length of 30.82 inches. The scale of the negatives obtained with this lens is therefore as follows: 1 degree = 0.538 inch; or, 1 inch = 1.86 degrees. The lens used by Mr. PALMER has an equivalent focal length of 25.99 inches, making the scale of his negatives as follows: 1 degree = 0.454 inch; or, 1 inch = 2.20 degrees. The reproductions all have the same scale as the original negatives.

Unfortunately, owing to the close proximity of the comet to the Sun at first, and later to the pressure of other work, it was impossible to obtain a series of exposures of uniform length. Two exposures were made with each instrument on the first night to determine if possible any evidences of rapid changes in the struc-

ture of the tail. These showed the comet to be too faint to give anything satisfactory with a short exposure; therefore, the entire available time on subsequent nights was devoted to a single one. Later, when two long exposures could have been obtained, the comet had receded from the Sun, and consequently rapid changes would not be likely to occur. The exposures varied in length from half an hour to three hours and a half, most of them being from one to two hours in length.

The length of the tail was apparently greatest about May 10th. The photographs show it to have been more than nine degrees. Taking into account the distance of the comet from the Earth, and the angle between the tail and the line of sight, the tail must have been more than 15,000,000 miles long. At that time the comet was visible to the naked eye as a hazy star between the fourth and fifth magnitudes. According to the ephemeris by MÖLLER (*Astronomische Nachrichten*, No. 3556) the comet did not reach its second maximum of brightness until May 22d; yet by May 15th the tail had shortened to $5^{\circ} 40'$ with an exposure of $2^h 24^m$. Owing to the uncertainties produced by different conditions of the sky and various lengths of the exposure times, the changes in the length of the tail are perhaps less interesting than the changes in its shape.

The greatest change of which we have evidence took place between the exposure made on May 6th and that of May 7th. These negatives are too weak for reproduction, the exposures being each less than one hour in length. Upon the one of May 6th (exposure 30 minutes) the tail consists of one main branch, 7 degrees in length, with a short streamer on each side. Upon the negative of May 7th (exposure 55 minutes) there is quite a number of streamers on either side of the main branch, which is not so long as on the previous night, and the entire comet has the appearance which would be produced by the head rotating about an axis through the comet and Sun, giving to the tail a twisted aspect. It has this same general appearance on the photograph (here reproduced) of May 8th, but the twist seems to extend further from the head than on the previous night. Slight traces of this appearance are still to be seen on the photograph of May 9th. During all this time, with the exception of May 6th, the main portion of the tail extended in a straight line from the comet, but upon the date above mentioned there is a sharp bend in the tail at about three degrees from the head.



(1) May 18, 1899. 13^h 42^m to 15^h 28^m.

(2) May 19, 1899. 13^h 51^m to 15^h 26^m.

(3) June 5, 1899. 11^h 41^m to 15^h 12^m.

COMET *a* 1899 (SWIFT).

(Photographed by H. K. PALMER.)

Turning to the reproduction of May 18th, we see that the tail was then slender and decidedly curved. On the following night it was more curved, and presented the peculiar appearance of having been split down the middle and one half taken off, leaving a sharp line along the concave side of the tail. The photograph of June 5th shows a short, stubby tail with a bright streamer about half as long on each side. Most of the photographs show anywhere from one to seven streamers extending from the head or from various parts of the tail. The number of these was rarely the same on two consecutive nights, while their positions and lengths were constantly changing.

In the plate taken June 9th the nebulosity about the head of the comet had become elliptical in form and almost pronounced enough to suggest the formation of another tail at an angle of fifteen degrees from the main one. On the following night this projection had developed into two rudimentary tails. On June 13th, these still retained their position and form, while the main branch had become much fainter, but had not diminished in length. Unfortunately, the comet had then become so faint that it was almost impossible to see it behind the dark cross-wires used in guiding, and no more photographs were obtained.

At the end of nearly all the exposures made by Mr. PALMER the slide was pushed in about seven eighths of the way. The clock was then stopped, and the stars were allowed to trail on one end of the plate. By means of these trails the position-angles of what appeared to be the axis of the tail were measured. The following table gives these measures, together with the computed values of the position-angle of the radius-vector of the comet:—

POSITION-ANGLES OF THE TAIL.

Date.	Tail.	Radius-vector.	$t-r$.
May 7	275°.1	273°.0	+ 2°.1
8	271°.1	272°.7	— 1°.6
9	269°.1	272°.2	— 3°.1
10	270°.8	271°.9	— 1°.1
15	267°.1	267°.6	— 0°.5
18	260°.6	263°.0	— 2°.4
19	260°.8	260°.5	+ 0°.3
20	256°.5	258°.4	— 1°.9

This table shows the observed values, on the average, to be slightly smaller than the computed, but the difference is only a little larger than the probable error of the best measures.

The scale of these photographs is too small to show any detail

about the head. In most cases it is shown as a bright central portion four or five minutes in diameter and usually circular, surrounded by a fainter nebulous portion from ten to fifteen minutes in diameter and often elliptical. In the cases where this nebulous portion was elliptical the major axis was not always coincident or parallel with the axis of the tail.

On June 5th the negatives taken with each instrument show the nucleus as a small bright dot less than one minute in diameter. On this date there seems to have been no nebulosity about the head, although it was twelve minutes in diameter. In the reproduction it appears sharper than on other dates. Unfortunately, the nucleus has disappeared in the process of reproduction.

PHYSICAL CHANGES OBSERVED IN THE HEAD OF SWIFT'S COMET.

BY C. D. PERRINE.

After passing perihelion, SWIFT's comet (1899 *a*) showed evidences of considerable internal action. Before perihelion it was simply a round mass of nebulosity, increasing in brightness towards the center, but with only a faint nucleus and little or no tail. The comet was then barely visible to the naked eye under good conditions. It again became visible in the latter part of April, after having been lost in the Sun's rays for nearly a month. It was then much changed in appearance, being much brighter and easily visible to the unaided eye. The nucleus had become much condensed and much brighter — resembling a star of $6\frac{1}{2}$ or 7th magnitude, with low magnifying powers. It also had a tail several degrees in length. It was first observed with the 36-inch refractor on the morning of May 7th, with a magnifying power of 270. The seeing was not good, the star-images being considerably blurred.

The following notes were made at the time: "No structure to be detected in the coma. The nucleus is sharp and under the atmospheric conditions existing does not differ from a star. Nucleus fully 7th magnitude, possibly brighter. North preceding the nucleus there is a small appendage brighter than the surrounding coma — about 10" in length and half as wide. The head of the comet fills the entire field (6' in diameter)."